



# 2007 Minerals Yearbook

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## LAOS

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# THE MINERAL INDUSTRY OF LAOS

By John C. Wu

Laos was a landlocked, mineral-rich developing country in Southeast Asia. During the past 5 years, Laos had attracted foreign investors from Australia, Canada, the Republic of Korea, Russia, and neighboring China, Thailand, and Vietnam to participate in investing in Laos's mining sector. The investment interest was largely owing to the Laotian Government's aggressive efforts to promote mining investment and to strengthen its management and regulation of the mining sector under the framework of the Mining Law of 1997 and the Investment Law. According to the Laotian Department of Geology and Department of Mines, which are part of the newly established Ministry of Energy and Mines, the country's geologic potential for bauxite, coal, copper, gold, gypsum, iron ore, potash, sapphire, and silver is excellent and that for construction materials (such as clays, dolomite, and limestone), lead, tin, and zinc is good (Ministry of Energy and Mines, 2007, p. 1).

Under the Ministry of Energy and Mines, which was established in June 2006, the Department of Geology comprised four divisions and one special unit—the Administration, Analytical, Geological, and Information Divisions and the Geological Survey Unit. The major functions of the Department of Geology are to (1) draft a strategic mineral development plan and regulations; (2) conduct country-wide geologic mapping and mineral investigations; (3) maintain and manage the country's geologic and mineral databank; (4) provide mineral prospecting, exploration, information, and mineral analysis services; and (5) conduct research in the geosciences, such as geochemistry. The Department of Mines comprised five divisions—the Administration, Agreement and Law, Environmental and Inspectorate, Mining Concession, and Technical Divisions. The major functions of the Department of Mines are to (1) draft mining policy and regulations for monitoring exploration and mining activities; (2) provide technical opinions on concessions for mineral exploration and exploitation; (3) participate in negotiation of mineral exploration and production agreements; (4) issue, extend, and withdraw mining licenses; (5) monitor and inspect mining activities; and (6) promote mining investment (Ministry of Energy and Mines, 2007, p. 5-6).

The number of investment projects in the mining sector in 2006 totaled 118, of which 33 projects were funded by foreign investors. Of the 118 projects, 55 were exploration projects; 36, mining projects; and 27, general geologic survey projects. The targeted minerals included antimony, barite, coal, copper, gemstones (ruby and sapphire), gold, gypsum, iron ore, lead, limestone, manganese, potash, salt, silver, tin, and zinc (Ministry of Industry and Handicraft, 2004, p. 16-19; Viyaketh, 2006, p. 10, 12-14).

According to a Chinese local press report in Jiangxi Province, 43 Chinese technical experts from the Bureau of Geology of Jiangxi Province were expected to travel to Laos early in 2007 to explore for iron ore resources for about 100 days. The 43 experts were from China's top-rated Jiangxi Provincial

Geologic Survey Team No. 912 and had an exploration budget of about \$75 million (Ky114.CN, 2007).

## Minerals in the National Economy

The mining sector, which was dominated by the mining of copper, gold, gypsum, limestone, silver, tin, and zinc, had become an important sector of the Laotian economy because of its increasing contribution to the country's gross domestic product (GDP) and increasing export earnings. According to the latest data provided by the authorities of Laos to the International Monetary Fund, the mining and quarrying sector, which grew by 87% in 2006 (the latest year for which data were available), contributed 5.3% to the Laotian GDP in 2006 compared with 3.1% in 2005 and 1.5% in 2004. In 2006, copper export earnings were estimated to be \$409.3 million and accounted for 41.1% of total merchandise exports, which had an estimated value of \$996.0 million; gold export earnings were estimated to be \$116.1 million and accounted for 11.6% of total merchandise exports. In 2006, imports of petroleum (which was the top mineral commodity import) had an estimated value of \$201.3 million and accounted for 14.5% of total merchandise imports, which were valued at an estimated \$1,384.1 million (International Monetary Fund, 2007, p. 32, 47).

## Production

In 2007, production of mineral commodities in Laos included barite, carbonate rocks (construction aggregate and limestone for cement manufacturing), clay, coal (mostly lignite), copper, gemstones (mostly sapphire), gold, gypsum, rock salt, sand and gravel, silver, tin, and zinc (table 1). In terms of the market value, copper, gold, gypsum, silver, tin, and zinc were the top six mineral commodities produced in Laos.

In 2007, copper, gold, and silver were produced mainly by Oxiana Ltd. of Australia from its Sepon copper-gold project at the Sepon open pit and at the Khanong pit, which is located about 40 kilometers (km) north of the town of Sepon in Savannakhet Province. Gold was also produced by Pan Australian Resources Ltd. (PAR) from its Phu Kham Heap Leach Gold Operation (Laos) (formerly called the Phu Bia Gold Mine) in Vientiane Province (Saysomboun Special Zone, which was dissolved in 2006). According to the former Department of Geology and Mines, an underground copper mine had been operated by Lao-China Oriental Minerals Development Co. Ltd. (a joint venture of the Governments of Laos and China) in the Long District of Luangnamtha Province since 2005, and a small-scale alluvial gold mine was operated by Phialat Gold Panning (another joint venture of Laos and China) in the Sangthon District of Municipality Province. The production data for the two joint-venture operations, however, were not available. Gypsum was produced by Lao State Gypsum Mining Co. Ltd. and Savan Gypsum Mining Co. Ltd. from the Champphon

District, Savannakhet Province, by LAVICO Co. Ltd. (a joint venture of the Governments of Laos and Vietnam) from the Xebangfay District in Khammouane Province, and by Mining Development (COEDCD) of Vietnam from Tha Kect District in Khammouane Province. Tin was produced by the Lao-North Korean Tin Mines (a joint venture of the Governments of Laos and North Korea) from the Hinboun District, Khammouane Province. Zinc was produced by a joint venture of the Laotian Government and Padaeng Industry Public (Laos) Co. Ltd. of Thailand from the Kaiso Mine in Vang Vieng, Vientiane Province, and by First Pacific Mining Co. Ltd. (FPM) in partnership with Rox Resources Ltd., from the Pha Luang Mine, which is also located in Vang Vieng, Vientiane Province.

## Structure of the Mineral Industry

The Laotian mineral industry consisted of four medium-sized companies from Australia, China, and Thailand that mined coal, copper, gold, lead, silver, and zinc; more than eight joint-venture firms that mined gypsum, gemstones, limestone, and ores of tin and zinc or manufactured cement; several state-owned and privately owned companies that mined barite, coal, gemstones, and limestone; and many small-scale local mining companies that quarried stones, sand and gravel, and other construction materials (table 2).

According to the former Laotian Department of Geology and Mines, among the 35 mines that operated in 2006, 23 were industrial mineral mines; 9, metal mines; and 3, sapphire mines. The industry's mining activities can be categorized into the following three groups: (1) three or four medium-scale mines used modern technology and equipment for mine production and mineral processing, (2) many small-scale mines used outdated technology, equipment, and mining methods, and (3) many illegal artisanal gold miners operated without registered mining rights (Shingu, 2006, p. 1).

## Commodity Review

### Metals

**Copper.**—Copper resources in Laos were estimated to be about 6 million metric tons (Mt) of copper metal, of which copper reserves were estimated to be about 2.9 Mt. Copper reserves of the skarn type were found at the Khanong copper deposit of the Sepon Mine, and those of the porphyry type related to Late Paleozoic granite rocks were found at the Phu Kham copper deposit (Ministry of Energy and Mines, 2007, p. 2).

Oxiana Ltd., which operated the Sepon copper-gold project through its 90% owned subsidiary Lane Xang Minerals Ltd. (LXML), produced copper from the Khanong deposit (an open pit that was part of the Sepon Mine) and a whole-of-ore atmospheric leach, pressure oxidation, solvent extraction and electrowinning copper processing plant. In June 2007, the Government of Laos officially acquired a 10% interest in LXML. Production of refined copper (copper cathode) increased by 2.9% to 62,541 metric tons (t) in 2007 from 60,803 t in 2006. Oxiana copper cathodes were exported to China, Malaysia, Thailand, and Vietnam. According to Oxiana, the amount of ore

mined from the Khanong open pit mine decreased to 1.94 Mt in 2007 from 2.32 Mt in 2006, and that of ore treated at the copper processing plant remained steady at about 1.3 Mt in 2007. The average head grade, however, increased to 5.65% copper in 2007 from 5.56% copper in 2006. The Khanong copper ore body was thought to be one of the highest grade copper ore bodies in the world (Oxiana Ltd., 2008b, p. 6; 2008d, p. 1).

Copper exploration at Sepon in 2007, which was focused on the Khanong and the Thengkham deposits, had found new high-grade copper resources at the Pha Bing prospect. With new resources added to the inventory, Oxiana approved a plan in December 2007 to expand the capacity of its Sepon copper processing plant from 60,000 metric tons per year (t/yr) to 80,000 t/yr by 2010 at an estimated capital cost of \$178 million. The copper expansion project at Sepon, which started in late 2007 and was scheduled to be completed by the first quarter of 2009, would increase throughput to 2 million metric tons per year (Mt/yr) from 1.35 Mt/yr and would reduce operating costs by 10% (Oxiana Ltd., 2008b, 2008c, p. 9-11).

In 2007, PAR focused mainly on development of its \$241 million Phu Kham copper-gold mine, which is located about 120 km north of Laos' national capital, Vientiane. By the end of 2007, construction was near completion. The project was scheduled to start operations in March 2008. In Phase 1, the Phu Kham copper-gold mine would have an initial mining capacity of 12 Mt/yr of ore that would be processed through a conventional flotation plant to produce about 240,000 t/yr of concentrate containing 60,000 t of copper, 1,900 kilograms (kg) (60,000 troy ounces) of gold, and 19 t (600,000 troy ounces) of silver. In Phase 2, beginning in 2010, the normal treatment rate would be increased to 16 Mt/yr from 12 Mt/yr and the capacity of the flotation plant to produce copper concentrate would also be increased. The copper concentrate would be exported for custom smelting, most likely in Thailand. As of December 2007, ore reserves at the Phu Kham copper-gold mine were estimated to contain 1.02 Mt of copper, 41 t [1.32 million troy ounces] of gold and 323 t (10.4 million troy ounces) of silver (Pan Australian Resources Ltd., 2008b, p. 5; 2008c).

**Gold and Silver.**—In 2007, gold and silver resources in Laos were estimated to be 15.5 Mt of ore containing 47 t (1.5 million troy ounces) of gold and 81 t (2.6 million troy ounces) of silver at the gold-bearing ore bodies of the Sepon Mine and 28.6 Mt of ore containing 31.7 t (1.02 million troy ounces) of gold at Phu Kham Heap Leach Gold Operation (formerly known as the Phu Bia Gold Mine) in Vientiane Province. According to the Ministry of Energy and Mines, an airborne geophysical survey had found extensive but low-grade copper and gold mineralization at Xanakham, which is located west of Vientiane. The Ministry also indicated that other potential gold occurrences were found in many locations in the Provinces of Attapeu, Bolikhamxay, Oudomxay, and Vientiane. The Government estimated that the country's gold potential was probably between 300 and 400 t (Ministry of Energy and Mines, 2007, p. 2).

Production of gold and silver by Oxiana from the Sepon open pit mine decreased by 41% to 3,185 kg (102,390 troy ounces) and by 29% to 4,500 kg (144,648 troy ounces), respectively, in 2007. The decreased gold and silver production in 2007 was caused mainly by the reduction in ore mined and milled,

lower average head grade, and a lower gold and silver recovery rate. According to Oxiana, the Sepon open pit mine produced 1.51 Mt of oxide ore in 2007 compared with 2.88 Mt in 2006; the amount of ore milled was 2.2 Mt in 2007 compared with 2.91 Mt in 2006. The treatment rate at the processing plant, which had a conventional carbon-in-leach circuit, was 2.2 Mt/yr in 2007 compared with 2.5 Mt/yr in 2006. Gold and silver recovery rates were 81.5% and 23.0%, respectively, in 2007 compared with 83.7% and 24.1%, respectively, in 2006. As a result, the total cash operating cost rose to \$445 per troy ounce in 2007 compared with \$330 per troy ounce in 2006 (Oxiana Ltd., 2007, p. 12; 2008b, p. 3; 2008c, p. 12). As of June 30, 2007, Sepon gold resources totaled 106 t (3.4 million troy ounces), and silver resources totaled 389 t (12.5 million troy ounces) compared with 103 t (3.3 million troy ounces) and 504 t (16.2 million troy ounces), respectively, as of June 30, 2006 (Oxiana Ltd., 2008a, p. 1).

PAR, through its 90% owned subsidiary Phu Bia Mining Ltd., which operated Phu Kham Heap Leach Gold Operation (known as the Phu Bia Gold Mine prior to 2007) using heap leaching from October 2005 to December 2006, produced 109.89 kg (3,418 troy ounces) of gold in 2005 compared with 671.12 kg (21,557 troy ounces) of gold in 2006. Gold production at the Phu Kham Heap Leach Operation in 2007 was 976 kg (31,380 troy ounces). In 2007, the Government of Laos had exercised its option to acquire a 10% interest in Phu Bia Mining, and PAR's interest was reduced to 90%. According to the company, the increased gold production in 2007 was attributable to successful implementation of a seasonal production strategy and improved operating practices and processing plant performance. PAR expected that its heap leach gold production would continue to exceed 93.31 kg (3,000 troy ounces) per month before the beginning of the wet season in May, as heap leach operations were limited to the dry season months, normally from October to April of the following year (Pan Australian Resources Ltd., 2008a, p. 5).

**Lead and Zinc.**—FPM, a Laotian company, obtained 5-year (2003–08) exploration licenses in 2003 to explore for barite, copper, gold, iron ore, lead, and zinc in an 800-square-kilometer ( $\text{km}^2$ ) area and for coal and iron ore in a 312- $\text{km}^2$  area near Kasi in the Vangvieng District of Vientiane Province. FPM reportedly was exploring for barite, lead, and zinc. At the same time, the company was mining near-surface high-grade (of more than 37% zinc) zinc oxide ore at the Pha Luang 2 and 3 prospects and mining lead sulfide and lead oxide at Nam Yen. FPM produced about 7,000 t of zinc ore at a grade of 33% zinc in 2005 (Shingu, 2006, p. 2).

Rox Resources Ltd. of Australia had reached an agreement in 2005 to acquire a 60% interest in the Pha Luang lead-zinc joint-venture project, which is located about 180 km north of Vientiane. Other partners of the joint venture were FPM (23%) and Triple Nine Mining Co. Ltd. of Thailand (17%). Drilling by Rox Resources during March–April 2006 discovered a zone of rich lead-zinc sulfide mineralization at Nam Yen. During 2007, Rox Resources continued its drilling program at the Pha Luang lead-zinc project to extend the previously defined mineralization for Mississippi Valley-type lead-zinc ore with several significant mineralized intercepts at the Nam

Yen prospect. The company's soil survey work also found a significant anomaly at the Pha Sod prospect, and its drilling program undertaken at the Pha Sod prospect intercepted several low-grade zinc sulfide mineralization zones. Further drilling at the prospect was planned. To assess the potential for deeper primary mineralization at the Pha Luang, a major induced polarization geophysical survey was completed at the Bon Noy and Na Yen prospects. The company reported that its application for a foreign investment license in 2006 had been delayed owing to a complicated issue involving the separation of the oxide and sulfide rights for its existing mining concession (Rox Resources Ltd., 2007, p. 4–9).

## Mineral Fuels

**Coal.**—Laos' coal reserves were estimated to be 347 Mt, and lignite resources at the Hongsaa deposit in Sayabury Province were estimated to be about 700 Mt. Coal occurrences and deposits have been discovered in many locations in the Provinces of Oudomxay, Saravan, Sayabury, Vientiane, and Xiengkhouang. According to the Department of Geology, Viengphoukha Coal Mine PCL of Thailand produced 222,423 t of lignite from the Viengphoukha District in Luangnamtha Province, and the state-owned Agriculture Industry Development Enterprise produced 35,000 t of anthracite coal from Vangvieng District in Vientiane Province in 2005 (the latest year for which data were available). Lignite output was exported to Thailand, and anthracite was for local consumption mainly by the cement plants in Vangvieng, Vientiane Province (Ministry of Industry and Handicraft, 2004, p. 4; Shingu, 2006, p. 2).

In November 2007, Ratchaburi Electricity Generating Holding PCL, which was Thailand's leading private power producer, announced that it would invest about \$2.6 billion in the 1,653-megawatt Hongsaa lignite-fueled (coal-fired) powerplant in Laos to increase its power generating capacity. The Hongsaa powerplant project would be owned by Banpu Power Co. Ltd., which was Thailand's leading private coal producer (40%), Ratchaburi (40%), and the Government of Laos (20%). According to Ratchaburi, another joint venture would be established to develop a coal mine at the Hongsaa deposit in Sayabury Province. The coal mine development project would be owned 37.5% each by Banpu and Ratchaburi, and the Government of Laos would own the remaining 25% (Reuters, 2007).

## Outlook

During the next 3 years, the mining sector of Laos is expected to continue to expand. Oxiana is expected to increase its copper and gold production capacity at its Khanong copper mine. Production capacities for copper and gold are likely to be boosted by PAR when the development and expansion of the Phu Kham copper-gold project and the Phu Bia gold project are completed and come onstream in 2008. During the next 2 to 4 years, Chinese investment in the mining sector may include investment in potash production in Vientiane and development of iron ore mines in Xiengkhouang Province. Other foreign investment potential includes Rox Resources' development of lead and zinc at the Nam Yen, Phu Luang 2, and Phu Luang 3

prospects in the Kasi area of Vientiane Province and Banpu's and Ratchaburi's development of lignite coal at the Hongsa Mine in Sayabury Province.

The Laotian economy is projected to continue to expand because the country's mining sector is expected to increase its contribution to the country's GDP through increased production and exports of copper, gold, silver, and zinc during the next 2 to 3 years. The Laotian economy grew by 7.5% in 2007 and was projected to grow by 7.9% in 2008 and by 8.2% in 2009 (International Monetary Fund, 2008).

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TABLE 1  
LAOS: PRODUCTION OF MINERAL COMMODITIES<sup>1,2</sup>

(Metric tons unless otherwise specified)

Commodity	2003	2004	2005	2006 <sup>c</sup>	2007 <sup>c</sup>
Barite	18,070	10,470	28,500 <sup>r</sup>	29,000	29,000
Cement <sup>e</sup>	250,000	250,000	250,000	400,000	400,000
Clay	51,866	58,718	8,155	5,200	5,500
Coal, lignite	212,819	332,907	232,934	233,000	620,000
Copper:					
Mine output, Cu content	--	--	39,943 <sup>r</sup>	89,092 <sup>r</sup>	99,040 <sup>3</sup>
Metal, refined	--	--	30,480	60,803 <sup>3</sup>	62,541 <sup>3</sup>
Gemstones, sapphire	carats 2,302,973	712,320	1,180,000 <sup>r, e</sup>	1,200,000 <sup>r</sup>	1,200,000
Gold	kilograms 8,879	6,760	7,058	6,088 <sup>r, 3</sup>	4,161 <sup>3</sup>
Gravel	549,300	40,000	97,400	100,000	120,000
Gypsum	101,727	201,094	774,000 <sup>r, e</sup>	775,000 <sup>r</sup>	775,000
Limestone <sup>e</sup>	379,000	518,000	750,000 <sup>r, e</sup>	750,000 <sup>r</sup>	750,000
Salt, rock	16,130	15,000	34,139	35,000	35,000
Sand, construction materials	549,300	98,900	85,300	90,000	100,000
Silver	kilograms 3,850	2,735	3,405	6,331 <sup>3</sup>	4,500 <sup>3</sup>
Tin, mine output, Sn content <sup>e</sup>	360	400	450 <sup>r</sup>	450 <sup>r</sup>	450
Zinc, mine output, Zn content <sup>e</sup>	850	950	3,410 <sup>r</sup>	1,100 <sup>r</sup>	1,100

<sup>c</sup>Estimated; estimated data are rounded to no more than three significant digits. <sup>r</sup>Revised. -- Zero.

<sup>1</sup>Table includes data available through May 11, 2008.

<sup>2</sup>In addition to the commodities listed, crude construction materials, such as sand and gravel, and varieties of stone were produced irregularly.

<sup>3</sup>Reported figure.

Sources: Laos' Ministry of Industry and Handicraft, Lao PDR 2004 Mineral Yearbook; U.S. Geological Survey Minerals Questionnaire for Laos (2002-05); Oxiana Ltd. Annual Reports 2005-06 and Quarterly Reports 2005-07; Pan Australian Resources Ltd., Annual Report 2006 and Quarterly Reports 2005-07.

TABLE 2  
LAOS: STRUCTURE OF THE MINERAL INDUSTRY IN 2007

(Metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners		Location of main facilities	Annual capacity <sup>e</sup>
Barite	Barite Mining Co., Inthavong Mining Co., Lao Development Construction Co., Phethongkham Co., Oravan Barite Co., and Singphouufar Co.		Muongfuong and Sanakham, Vientiane Province	30,000 <sup>1</sup>
Cement	Wanrong Cement I		Vangvieng, Vientiane Province	78,000
Do.	Wanrong Cement II (Yuannan Industrial Economic Co., 60%, and Agricultural and Forestry Development and Service Co. of Laos, 40%)		do.	200,000
Do.	Wanrong Cement III		Savannakhet Province	200,000
Coal:				
Anthracite	Agriculture Industry Development Enterprises		do.	60,000
Lignite	Viengphoukha Coal Mine Co. Ltd.		Viengphoukha, Luangnamtha Province	300,000
Copper:				
Mined ore output, Cu content	Lane Xang Minerals Ltd. (LXML) (wholly owned subsidiary of Oxiana Ltd.)		Sepon, Vilabouly District, Savannakhet Province	67,600
Refined	do.		do.	63,000
Gemstone (sapphire)	carats	Bokeo Mining Co. Ltd.	do.	300,000
Do.	do.	Buhae Industrial Corp.	Houaxay District, Bokeo Province	500,000
Do.	do.	Lao International Trade and Service	do.	400,000
Gold, mine output, Au content	kilograms	Lane Xang Minerals Ltd. (wholly owned subsidiary of Oxiana Ltd.)	Sepon, Vilabouly District, Savannakhet Province	7,500
Do.	do.	Phu Bia Mining Ltd. [wholly owned subsidiary of Pan Australian Resources Ltd. (PAR)]	Xaisomboun special zone, 100 kilometers northeast of Vientiane, Vientiane Province	1,600
Gypsum		Lao State Gypsum Mining Co. Ltd.	Champhon District, Savannakhet Province	200,000
Do.		Mining Development Economy Cooperation (OEDCD)	Tha Kect District, Khammouane Province	150,000
Do.		Savan Gypsum Mining Co. Ltd.	Champhon District, Savannakhet Province	70,000
Do.		LAVICO Co. Ltd. (a Lao-Vietnam joint venture)	Xebangfay District, Khammouane Province	100,000
Limestone		Lao Cement Co. Ltd. (a Lao-China joint venture)	Vangvieng, Vientiane Province	250,000
Do.		Agricultural Industry Development Enterprises	do.	150,000
Do.		V.S.K. Co. Ltd.	Tha Kect District, Khammouane Province	150,000
Do.		Phanangnon Co. Ltd.	do.	100,000
Tin, mine output, Sn content		Lao-North Korea Tin Mines	Hinboune District, Khammouane Province	120
Do.		S V Mining Co. Ltd.	do.	300
Zinc, mine output, Zn content		Padeang Industry Public (Laos) Co. Ltd. [Majority interest owned by Padeang Industry (Public) Co. Ltd., and minority interest owned by the Government of Laos]	Kaiso, Vangvieng, Vientiane Province	1,100

<sup>e</sup>Estimated; estimated data are round to no more than three significant digits. Do., do. Ditto.

<sup>1</sup>Estimated combined capacity of the six local barite mining companies.